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(72) Inventors REGINALD MURRAY

SPECIFICATION NO 1415507

By a further direction given under Section 17 (1) of the Patents Act 1949 this application proceeded in the name of ASSOCIATED ENGINEERING LIMITED, a British company, of Ince House, 60 Kennilworth Road, Leamington Spa, Warwickshire.

THE PATENT OFFICE

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[illegible] engine or compressor, and formed of a composite material made of grains of plate-like particles of aluminium or aluminium-based alloy and of alumina in the proportions (neglecting impurities) of 55 to 80% aluminium or aluminium-based alloy and 20 to 45% alumina, said grains being randomly-orientated and each grain having the plate-like particles of which it is composed arranged with their major axes generally parallel to one another.

In this specification the use of the term "grains" is not intended to imply that these have a crystalline structure.

From another aspect the invention consists in an engine or compressor having a cast iron cylinder block or housing and a seal as defined above, the seal being in sliding engagement with the cast iron cylinder block or housing to effect a seal therebetween.

Commercial grades of both the aluminium-based alloy and the alumina contain impurities and it is estimated there is up to 5% by weight impurity in a completed seal. Clearly the exact quantity of impurity depends upon the commercial grade taken.

Seals having compositions within the [illegible] and alumina simultaneously onto a collecting surface to form a coating, removing said coating from the collecting surface and forming the seal from the coating. The seal may be formed by sintering or forging the coating material or by crushing the coating material and sintering, forging or hot pressing the powder formed thereby.

The invention will now be described, by way of example, as applied to an apex or tip seal for the piston of a rotary piston engine, e.g. of the Wankel type. Such an apex seal is generally in the form of a rigid bar of suitable material, having the edge rounded, and may have a recess or rebate in one or both sides.

EXAMPLE 1

An apex seal weighing 30 grams was manufactured from a composite material of 55% by weight aluminuim-based alloy and 45% alumina. The aluminium-based alloy was a powder with a chemical composition equivalent to that described in BS 1490:1970, Aerospace specification L35, containing, in addition to aluminium, 4% copper, 2% nickel, 1.5% magnesium and 0.2% titanium.

The particle size of the powder was in the

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C7D 8A1 8D 8K 8R 8W 8Z9 A1

(72) Inventors REGINALD MURRAY and FRANCIS JAMES ATKINS

(54) SEAL MEMBERS

(71) We, ROPARCO LIMITED, a British Company of Ince House, 60, Kenilworth Road, Leamington Spa, Warwickshire, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to engines and compressors and in particular to a seal for an engine or compressor.

According to one aspect, the invention consists in a rubbing seal for use in an engine or compressor, and formed of a composite material made of grains of plate-like particles of aluminium or aluminium-based alloy and of alumina in the proportions (neglecting impurities) of 55 to 80% aluminium or aluminium-based alloy and 20 to 45% alumina, said grains being randomly-orientated and each grain having the plate-like particles of which it is composed arranged with their major axes generally parallel to one another.

In this specification the use of the term "grains" is not intended to imply that these have a crystalline structure.

From another aspect the invention consists in an engine or compressor having a cast iron cylinder block or housing and a seal as defined above, the seal being in sliding engagement with the cast iron cylinder block or housing to effect a seal therebetween.

Commercial grades of both the aluminium-based alloy and the alumina contain impurities and it is estimated there is up to 5% by weight impurity in a completed seal. Clearly the exact quantity of impurity depends upon the commercial grade taken.

Seals having compositions within the [illegible] above ranges have been tested with considerable success running against cast iron surfaces.

The rubbing may be used as a piston apex seal or as a piston side seal in a rotary piston machine. Alternatively the rubbing seal may be used as a piston ring in a reciprocating piston machine.

Conveniently the seal is formed by a method including feeding the metal and the alumina simultaneously to a high temperature spraying means, spraying said metal and alumina simultaneously onto a collecting surface to form a coating, removing said coating from the collecting surface and forming the seal from the coating. The seal may be formed by sintering or forging the coating material or by crushing the coating material and sintering, forging or hot pressing the powder formed thereby.

The invention will now be described, by way of example, as applied to an apex or tip seal for the piston of a rotary piston engine, e.g. of the Wankel type. Such an apex seal is generally in the form of a rigid bar of suitable material, having the edge rounded, and may have a recess or rebate in one or both sides.

EXAMPLE 1

An apex seal weighing 30 grams was manufactured from a composite material of 55% by weight aluminuim-based alloy and 45% alumina. The aluminium-based alloy was a powder with a chemical composition equivalent to that described in BS 1490:1970, Aerospace specification L35, containing, in addition to aluminium, 4% copper, 2% nickel, 1.5% magnesium and 0.2% titanium.

The particle size of the powder was in the

range of 50—150 μm. The alumina was in the form of a powder containing 2.5% titanium oxide and having a particle size of 20—50 μm diameter.

The two powders were contained in separate powder feed hoppers for example as discluosed in U.K. Patent Application No. 3,643/71 (Serial No. 1,373,031), and are fed into a single plasma spray gun as disclosed in U.K. Patent Specification No. 1,240,125 and U.K. Patent Specification No. 1,281,166. The relative feed rates of the powders are adjusted to achieve the desired proportions in the final composite.

As the powders are fed simultaneously into the plasma gun and through the plasma arc, the particles melt and are accelerated to a high velocity. This results in a stream of molten droplets which is directed onto a rotating cylindrical mandrel. As the droplets impinge on the surface of the mandrel they spread out in the form of discs or platelets, rapidly losing their heat to the surface and solidifying. The surface of the mandrel becomes completely covered and continued spraying results in the build up of a material with a structure composed of many platelets of aluminium-based alloy and alumina, the platelets having their major axes generally parallel to one another. Due to the simultaneous feed of the powders into the gun there is a substantially uniform distribution of the platelets within the composite structure.

The plasma gun was traversed back and forth over the length of the rotating mandrel along a line parallel to its axis. When a suitable thickness of the material has been deposited, such as 2—5 mm, it is stripped from the mandrel and broken into pieces approximately 10 mm square. These pieces are then passed through a hammer mill, which is controlled to produce grains of the material in the range 100—800 μm diameter. Each of these grains contains a number of platelets of aluminium-based alloy and alumina, in each of which the platelets have their major axes generally parallel to one another.

The seal is produced from the grains of material by compaction in a metal die under the combined action of pressure and temperature. The shape of the seal is controlled by the form of the die body and punches, and the thickness by the quantity of material fed into the die. The pressure used for compaction is 78MNm^{-2} (5 tnfin^{-2}) with the die at a working temperature of 510°C. The pressure is applied until maximum density is obtained. The working faces of the die and punches may be pre-coated with a graphite release agent. This process produces a seal with an isotropic structure, since the grams containing the platelets of aluminium-based alloy and alumina are randomly orientated, i.e. the major axes of the platelets in one grain are not usually parallel to those of the next grain.

EXAMPLE 2

An apex seal weighing 30 grams was made from a composite material of 70% by weight aluminium-based alloy and 30% by weight alumina. The aluminium-based alloy was in the form of a powder with a chemical composition equivalent to that described in BS 1490:1970 LM13 and having in addition to aluminium 12% silicon, 1% magnesium, 1% copper and 2% nickel. The two powders were fed simultaneously into a plasma gun as was described in respect of Example 1.

Whilst the seal member described above has been found to possess excellent wear resisting properties, it has been found that when the seal co-operates with another body, such as the casing of a rotary engine, a particularly effective seal is provided when the other body is manufactured from cast iron.

Instead of the hot pressing process described above, the grains may be subjected to a normal sintering process after cold pressing.

Although an apex seal has been described, a seal for the sides of the piston in a rotary piston machine may be provided. Furthermore, the seal may be used as a piston ring in a reciprocating piston machine, but in this case some provision may be required to provide a radially expanding force to the piston ring. The seal may also be used in internal combustion engines or compressors.

WHAT WE CLAIM IS:—

1. A rubbing seal for use in an engine or compressor, and formed of a composite material made of grains of plate-like particles of aluminium or aluminium-based alloy and of alumina in the proportions (neglecting impurities) of 55 to 80% aluminium or aluminium-based alloy and 20 to 45% alumina, said grains being randomly-orientated and each grain having the plate-like particles of which it is composed arranged with their major axes generally parallel to one another.

2. A seal as claimed in claim 1, wherein the composite material is made from aluminium-based alloy and alumina powders in amounts of 55% by weight and 45% by weight respectively, the aluminium-based alloy containing, in addition to aluminium, 4% copper, 2% nickel, 1.5% magnesium and 0.2% titanium and the alumina powder containing 2.5% titanium oxide.

3. A seal as claimed in claim 2, wherein the particle size of the aluminium-based alloy powder is in the range 50 to 150 μm and the particle size of the alumina powder is in the range 20 to 50 μm.

4. A seal as claimed in claim 1, formed of a composite material of 70% by weight aluminium-based alloy and 30% by weight alumina, the aluminium-based alloy containing, in addition to aluminium, 12% silicon, 1% magnesium, 1% copper and 2% nickel.

5. A seal as claimed in any preceding claim, in the form of an apex seal or side seal for a rotary piston machine.

6. A seal as claimed in any of claims 1 to 4, in the form of a piston ring for a reciprocating piston machine.

7. An engine or compressor having a cast iron cylinder block or housing and a seal formed of a composite material of aluminium or an aluminium-based alloy and alumina, as claimed in any preceding claim, the seal being in sliding engagement with the cast iron cylinder block or housing to effect a seal therebetween.

8. Seals for engines or compressors as claimed in any of claims 1 to 6 and substantially as hereinbefore described.

9. The methods of making seals as claimed in any of claims 1 to 6 and substantially as hereinbefore described with reference to either of the examples.

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